Historic, archived document

Do not assume content reflects current
scientific knowledge, policies, or practices.

.31
op. 2

ARS 33-131
October 1968

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY
NOV 7 1968
CURRENT SERIAL RECORDS

CONVERSION OF A STANDARD REFRIGERATOR TO A BIOLOGICAL INCUBATOR

By G. R. Anderson, S. W. Johnson, H. G. Melanson,
and C. H. Schmidt[1]

INTRODUCTION

An inexpensive, reliable, and accurate biological temperature chamber with a sequential light sequence can be provided by modifying a standard household refrigerator to include (1) temperature span of 45° to 100° F., (2) temperature control of ± 0.5°, (3) a light sequence adjustable for 0.5 to 22.5 hours, and (4) a fail-safe control to prevent overheating or overcooling. The modifications can be made for about $300.

DESCRIPTION AND OPERATION

The temperature controller shown on the left at the top of figure 1 is the HEAT control; the controller on the right is the compressor (COOL control). The box on the extreme left houses the sequential light TIMER, and the mechanism on the extreme right is the FAIL-SAFE control. Shown between the HEAT and COOL controls are the master ON-OFF switch, the heating and cooling indicator lights, and the flashing fail-safe alarm light.

Both the heat and cool controls are set to the same operating temperature. Since both are 1° F. differential units, a small adjustment on either side of the set point (above for heat and below for cooling) will give the desired temperature control of ± 0.5°. At room temperatures, a "fighting" condition may exist between the heater and the compressor, since both controls can be on at the same time; but such a situation can be ignored because the compressor has a greater capacity than the heaters and will shut itself off. This condition can never exist at the extreme ends of operation.

The fail-safe control on the model illustrated in this report operates only for an upward deviation of the temperature, but other models are available that will control a decrease in temperature (table 1). The control can be set as close as 2°-3° F. above the set point. Then, if some electrical or mechanical failure causes the temperature to rise, the fail-safe control automatically shuts the entire system off and simultaneously turns on an audio-visual alarm, an electric buzzer, and a flashing red light. The incubator is not self-starting, but it can be put back into operation by first reducing the temperature inside and then by pushing the manual "reset" button on the fail-safe control. A manual fail-safe control was chosen to offset the lack of a temperature recorder; that is if temperature control is lost, the operator is aware of it.

---

[1] The first three authors are student assistants at the Metabolism and Radiation Research Laboratory, ARS, USDA, Fargo, N. Dak.; Dr. Schmidt, entomologist, was formerly stationed at the laboratory.

The sequential timer for the lights is a standard industrial clock timer; the tabs can be set for any sequence of on-off operation. The fluorescent lights are self-starting, and each has its own ballast.

The quantity of heat supplied by the heaters can be controlled with a HI-LOW switch located near the heaters (fig. 2). This switch allows for either half heat (125 watts) or full heat (250 watts). The master on-off switch controls the entire system except for the inside incandescent light, which is controlled by the door switch; it can be used to shut off the alarm system.

MODIFICATIONS

First, the back panel of the refrigerator is taken off, and the control and the associated wiring are removed. Holes are drilled into the top of the refrigerator where the control box and ballast box will be mounted (figs. 1, 3, and 4). Also, the sides of the deep freeze unit are cut out to allow for air circulation, and this metal is used to fashion a cover for the hole left by the refrigerator control (figs. 1 and 5).

The control box is prepared for component mounting by drilling all necessary holes (fig. 6) for the two temperature controllers (cooling and heating), the clock timer for the lights, the fail-safe temperature controller, the indicating thermometer, the master power switch, the heat and cool indicating lights, and the fail-safe alarm light (figs. 1, 3, and 4). The visual alarm-timer socket is mounted inside the control box (fig. 3). The ballast box for the fluorescent lights is prepared in the same manner as the control box, and the ballast and an interconnecting terminal strip are mounted inside the ballast box. The drip pan is fashioned from sheet aluminum and is used to prevent condensation from falling on the specimens. The fluorescent light sockets and associated wiring are fastened to the drip pan (figs. 1, 2, and 5).

The blower, heaters, and hi-low heat switch are mounted inside the freezer compartment and the drip pan below it (figs. 1, 2, and 5); the control and ballast boxes are mounted on the refrigerator (figs. 1-5), and the alarm buzzer is mounted on the refrigerator frame near the compressor to reduce vibrations. Now the sensing elements of the temperature controllers, the fail-safe, and the thermometer are routed over the top of the refrigerator. The elements for the temperature controller are installed in the freezer compartment, and those for the fail-safe and thermometer, inside the refrigerator (figs. 3 and 4) and fastened in position by plastic cable fasteners (figs. 1, 2, and 5).

The interconnecting wiring is installed last. The routing for the wiring from the control and ballast boxes is the same as that for the sensing elements, and standard industrial wiring procedures and wire are used. The schematic wiring diagram is shown in figure 7; the complete parts list is given in table 1.

TABLE 1.--List of parts needed for converting a standard refrigerator to a biological incubator

Description	Manufacturer and part number[1]	Quantity needed	Reference designation in figure 7
Temperature controllers, SPDT	Honeywell, #5675a-1516-1	2	T_1, T_2
Fail-safe controller, 4-wire, 2-circuit, temperature rise	Penn Controls, CS-7179	1	FS_1
Fail-safe controller, 4-wire, 2-circuit, temperature drop	Penn Controls, T-7406	1	---
Clock timer, SPST, lights	Paragon, #4001-0	1	Ti_1
Dial thermometer -40 - 120° F.	Honeywell, #W655A-F	1	---
Blower, 1/45 hp., 2,875 r.p.m. and bracket	Dayton, model 20782	1 each	F_1
Heating elements, 125 w.	Chromalox, #PT512	2	HTR_1, HTR_2
Toggle switch, DPDT	Arrow-Hart & Hegeman, #20905FR	2	S_1, S_2
Fluorescent lamp	General Electric, #F15T12/CW	4	FL_1
Ballast-rapid start	General Electric, #RL-2SP20	4	BAL_1
Buzzer, 115v., a.c.	Potter Brumfield, #BU-115AC	1	B_1
Alarm light, 6w., 110v.	General Electric, #S6	1	L_3
Pilot light	General Electric, #NE-51	2	L_1, L_2
Delay relay (flasher) 117v., 30 c.p.m.	Amperite, #115F30T	1	---
Chassis, 10X5X3 in.	Bud Radio, AC-404	1	---
Bottom plates, 5X7 in.	Bud Radio, BPA-1589	1	---
Minibox, 10X6X3 1/2 in.	Bud Radio, CU-2110-A	1	---
Tube socket, 9-pin	Cinch-Jones, #9EB	1	---
Fluorescent socket	General Electric, #78X491	8	---
Pilot lamp socket(red)	Dialco, #32-3101-043-302	1	---
24-terminal barrier strip	Cinch-Jones #24-141	1	---
Pilot lamp sockets (red and green)	Dialco, #42-0409-0995-241	1 each	---
Solderless terminals	Vaco, #C13306	50[2]	---
Hookup wire, 16 gage, stranded	Belden, #8500	20 feet[2]	---
Multiconductor cable, 12-wire	Belden, #8457	10 feet[2]	---
Cable straps	Panduit, #SSC2	10[2]	---

See footnotes at end of table. Continued

Table 1.--Continued

Description	Manufacturer and part number[1]	Quantity needed	Reference designation in figure 7
Sheet metal screws, #6X1/2 inch		30[2]	---
Machine screw, 4-40X3/8-inch nuts	---	2	---
Machine screws, 8-32X1/2 inch	---	30[2]	---
Machine screws, 6-32X3/8 inch	---	20[2]	---
Machine screws, 10-32X1/2 inch and nut	---	2	---
Wire nuts	---	4	---

---

[1] Mention of a proprietary product does not constitute a guarantee or warranty of the product by the U. S. Department of Agriculture and does not imply its approval by the Department to the exclusion of other products that may also be suited.

[2] Approximate value.

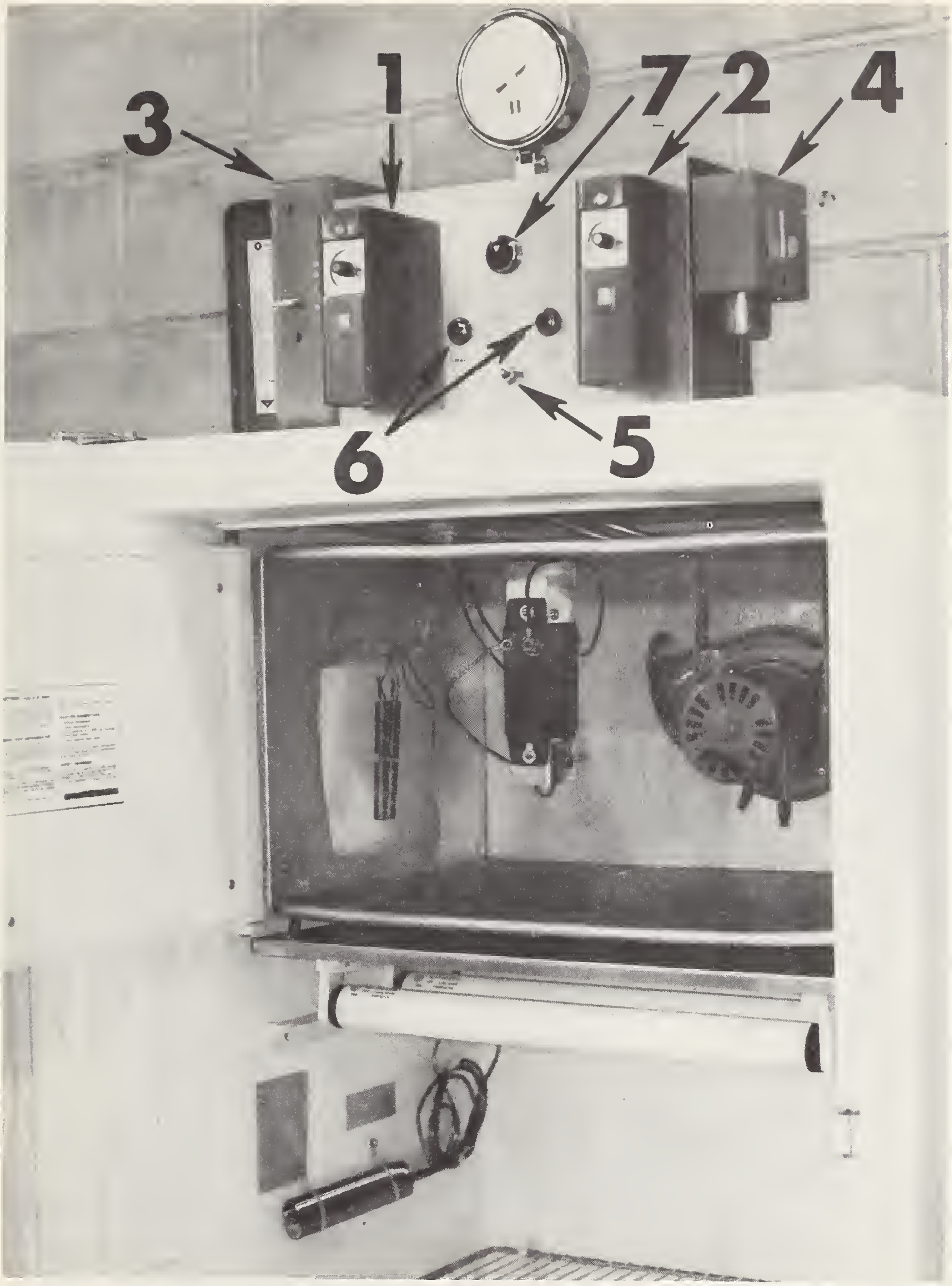


Figure 1.--Front view of modified refrigerator showing (1) heat control, (2) cooling control, (3) light timer, (4) fail-safe control, (5) master on-off switch, (6) heat-cool indicating lights, (7) visual alarm light.

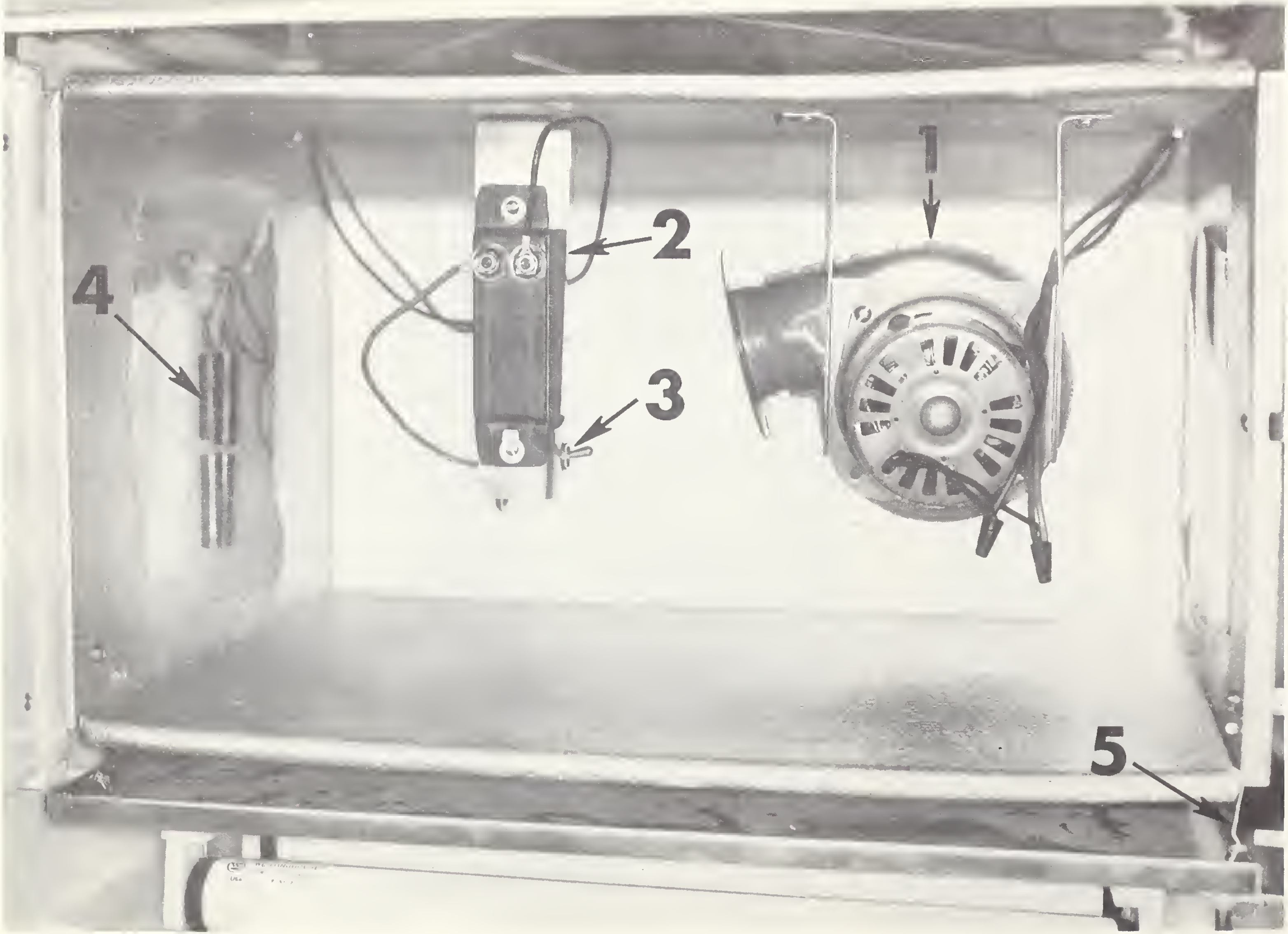


Figure 2.--Freezer compartment showing (1) blower, (2) heaters, (3) hi-low heat switch, (4) heat-cool controller sensing elements, (5) drip pan mounting bracket.

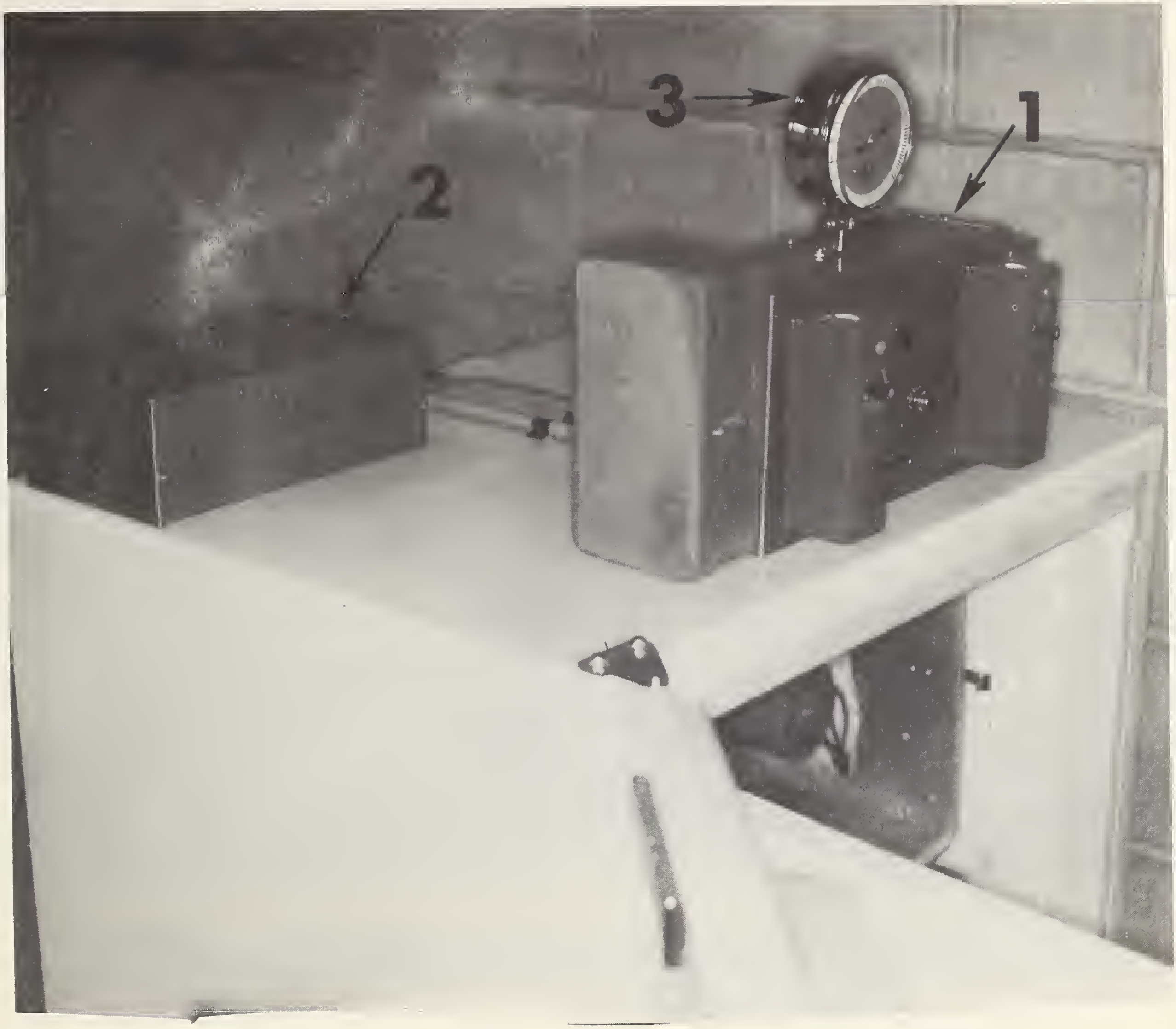


Figure 3.--Photograph showing (1) control box, (2) ballast box, (3) indicating thermometer.

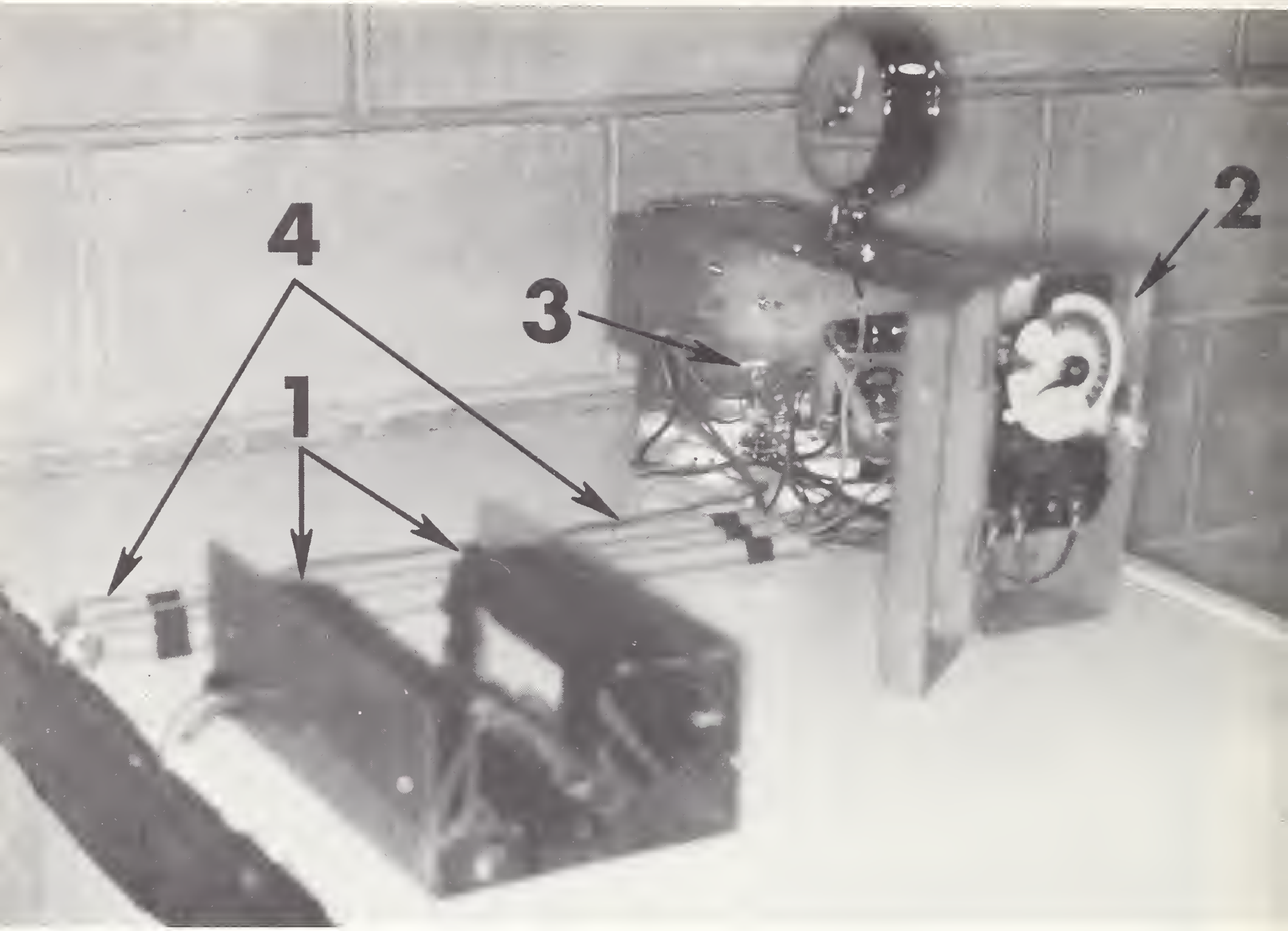


Figure 4.--Photograph showing (1) ballasts, (2) light timer, (3) visual alarm light flasher, (4) routing of wiring and sensing elements.

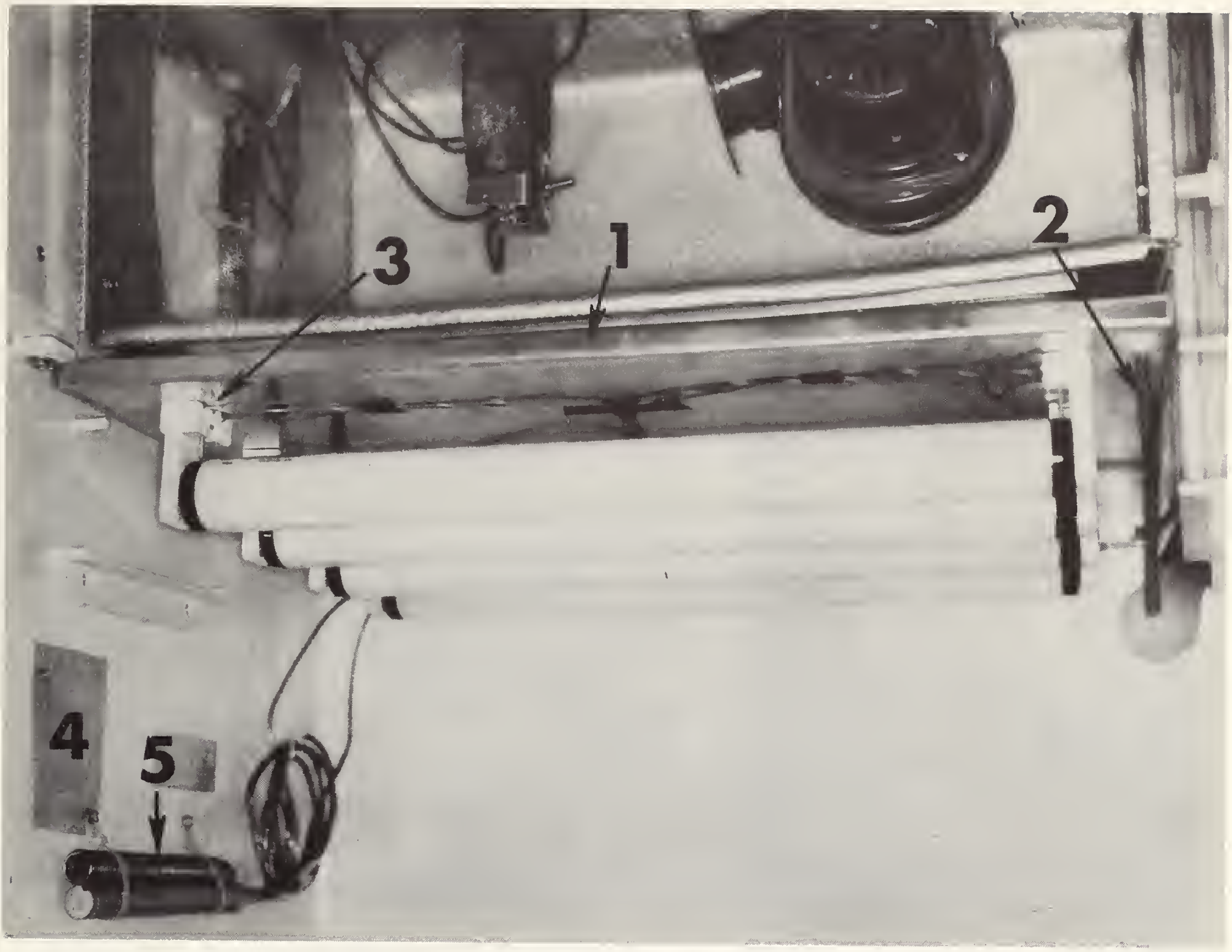


Figure 5.--Bottom view of freezer compartment showing (1) drip pan, (2) drip pan drain, (3) fluorescent light sockets and wiring, (4) old refrigerator control cover, (5) fail-safe controller and thermometer sensing elements.

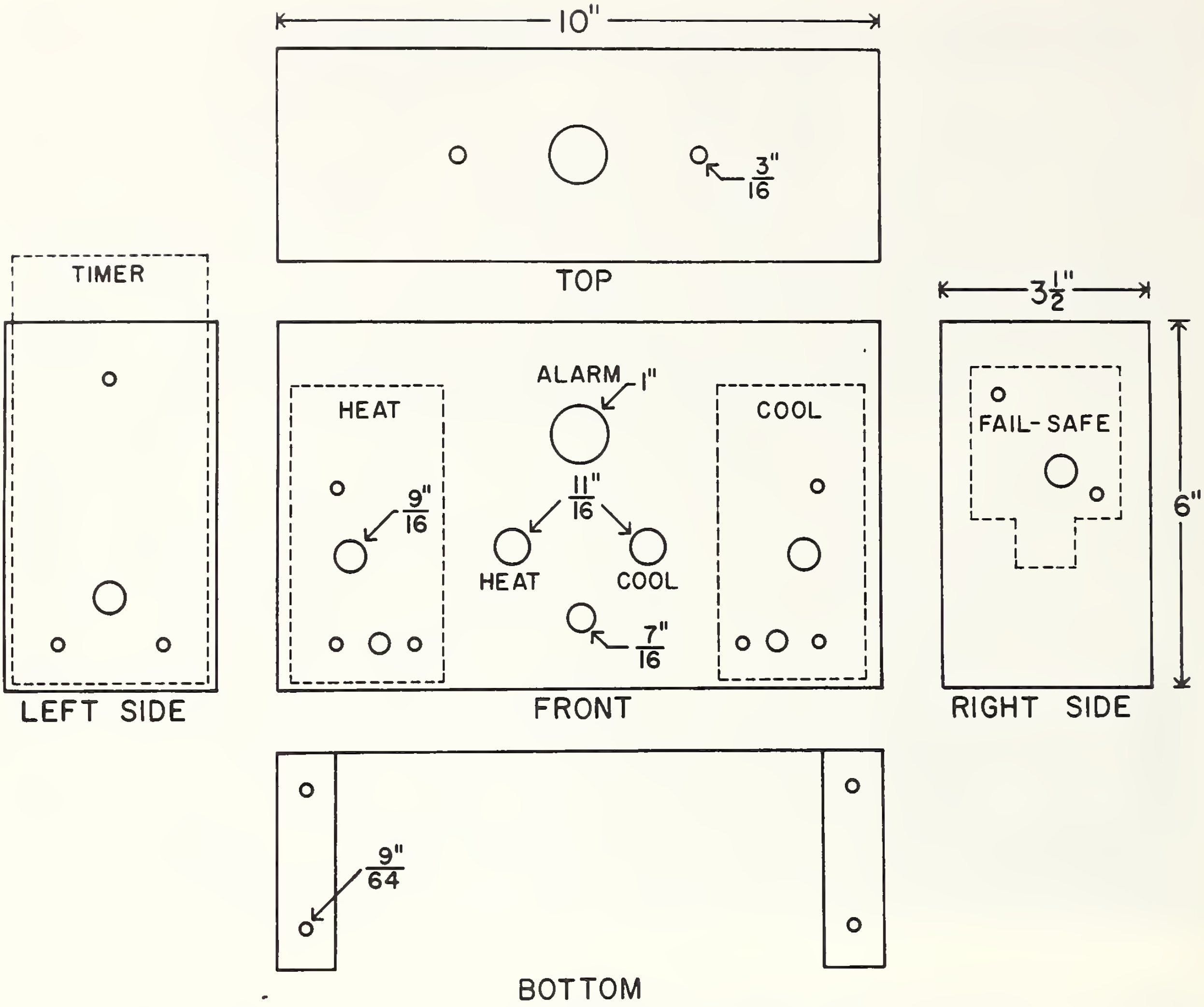
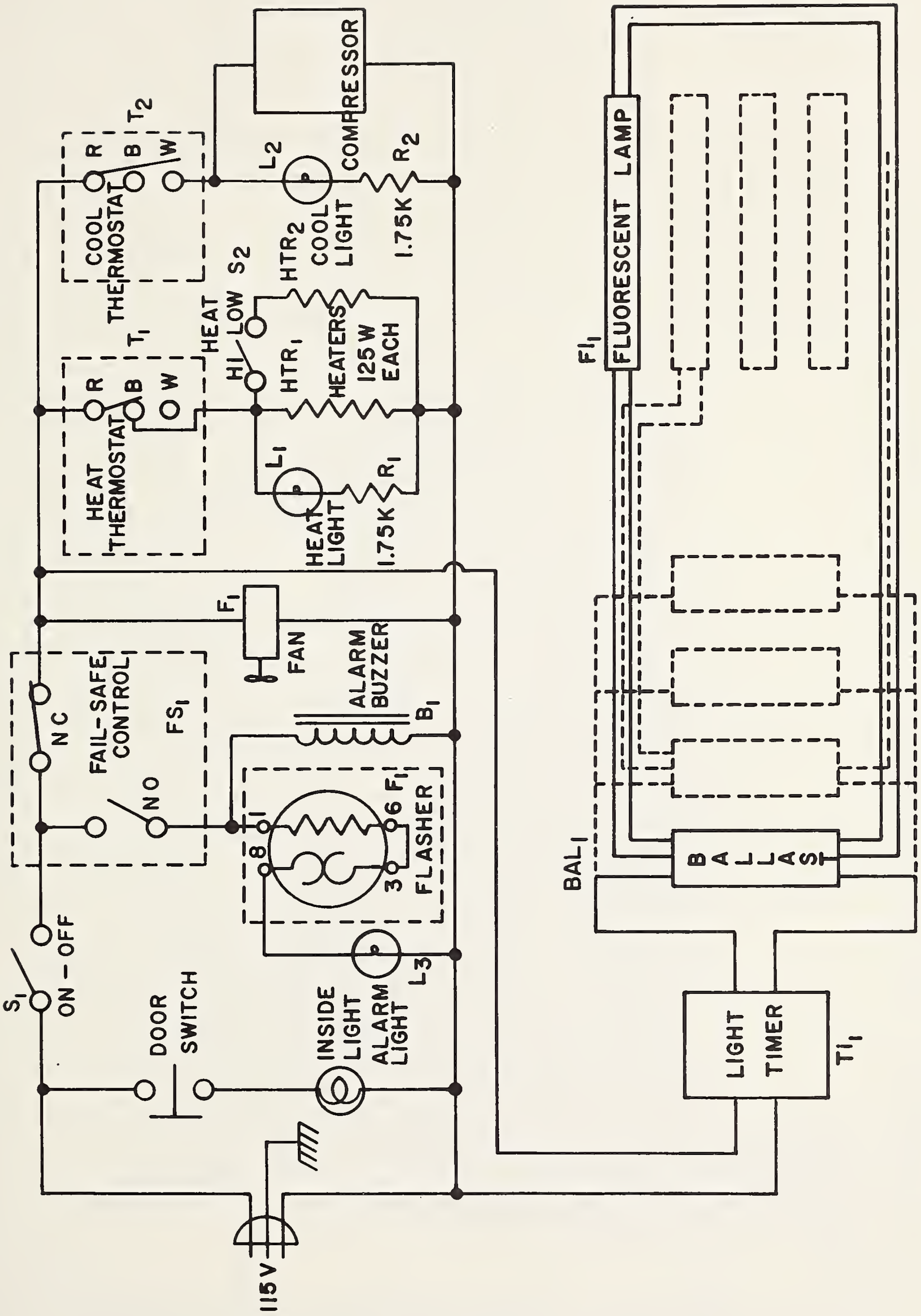


Figure 6.--Multiview of control box showing sizes of holes and approximate location.


115V
S1
ON - OFF
DOOR SWITCH
INSIDE LIGHT
ALARM LIGHT
L3
FAIL-SAFE CONTROL
FS1
NC
NO
FLASHER
F1
1
6
8
3
ALARM BUZZER
B1
FAN
F1
HEAT THERMOSTAT
T1
R
B
W
HEAT
HI
LOW
S2
HTR1
HTR2
HEATERS 125 W EACH
L1
R1
HEAT LIGHT
1.75K
COOL THERMOSTAT
T2
L2
R2
COOL LIGHT
1.75K
COMPRESSOR
FL1
FLUORESCENT LAMP
BAL1
BALLAST
LIGHT TIMER
TI1

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
BELTSVILLE, MARYLAND 20705

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF AGRICULTURE